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(54) Apron tensioning system for round balers.

(57) A system for tensioning the apron (41) of a round baler (10) includes a pair of springs (63) and a pair of hydraulic cylinders (68) connected between apron take up arms (56) and a tailgate (18) of the round baler (10). The springs (63) normally urge the apron take up arms (56) toward an inner position, and the hydraulic cylinders (68) resist movement of the apron take up arns (56) from the inner position to an outer position. The hydraulic cylinders (68) provide a primary source of apron tension and the springs (63) provide a secondary source of apron tension. During bale formation, the apron tension generated by the hydraulic cylinders (68) increases while the apron tension generated by the springs (63) remains substantially constant.

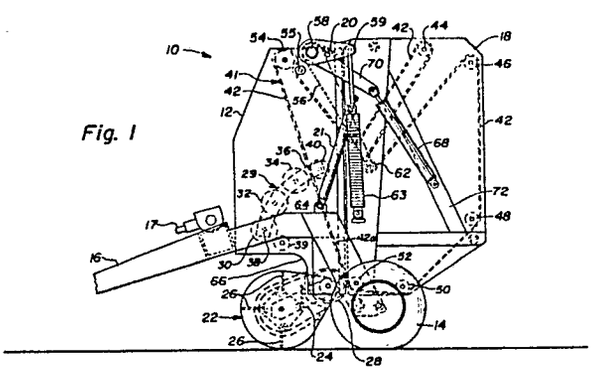

Fig. 1

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APRON TENSIONING SYSTEM FOR ROUND BALERS

This invention relates generally to roll baling machines typically referred to as "round balers" which form cylindrical bales of crop material and, in particular, to an apron tensioning system for such machines.

Round balers of the expandable chamber type disclosed in US-A-4.343.141 and US-A-4.426.833 have included a bale forming apron which is maintained under tension during bale formation by utilizing coil springs or air springs. One drawback of the coil springs disclosed in US-A-4.343.141 is that the tension in the apron cannot be quickly and easily released when servicing the baler. Another drawback of these coil springs is that they are bulky and heavy. The air springs disclosed in US-A-4.426.833 overcome these drawbacks but they are costly and require additional frame structure due to the high forces they exert. Furthermore, adjustability of the air springs is limited to decreasing the apron tension only unless an on-board air supply is included.

It is an object of the present invention to provide an apron tensioning system for round balers which provides relatively low apron tension for starting bale formation and relatively high apron tension when bale formation in the bale chamber is nearing completion.

Another object is to provide an apron tensioning system which permits quick and easy release of the tension in the bale forming apron and still another object is to provide an apron tensioning system which permits the tension in the bale forming apron to be increased and decreased without including an on-board air supply.

The present invention provides a system for tensioning bale forming apron means in a round baler. The apron means have an inner course defining at least in part a bale forming chamber which, in use, is expandable from a bale starting chamber to a full sized bale chamber. The apron inner course is extensible to at least in part accomodate for said bale chamber expansion. The apron tensioning system comprises :

- take up means which are cooperable with the apron means and movable from a bale starting position to a full sized bale position to permit extension of the apron inner course;
- resilient means cooperable with the take up means for normally urging the take up means toward the bale starting position and permitting these take up means to move toward the full sized bale position; and
- resisting means cooperable with the take up means for, together with the resilient means, providing resistance to the take up means when moving from said bale starting position to said full sized bale position to thereby induce tension in the apron means during bale formation.

In the preferred embodiment of the invention, the take up means are pivotally mounted on the main frame of the baler to which also a tailgate is pivotally connected. The resilient means comprise a pair of springs each having an upper end thereof connected to the take up means and a lower end thereof connected to the tailgate, and the resisting means comprise a pair of hydraulic cylinders each having one end thereof connected to the take up means and another end thereof connected to the tailgate. One of the springs and one of the hydraulic cylinders are disposed on each side of the baler. The resisting means provide a primary source of tension on the apron means while the resilient means provide a secondary source of tension on the apron means. The apron tension generated by the resisting means increases during bale formation while the apron tension generated by the resilient means remains substantially constant during bale formation.

A round baler embodying the present invention will now be described in greater detail by way of example with reference to the accompanying drawings, in which

Fig. 1 is a side elevational view of this round baler at the start of bale formation; and

Fig. 2 is another side elevational view of the round baler of Fig. 1 at the completion of bale formation.

Referring to Figs. 1 and 2, a round baler 10 according to the preferred embodiment of the present invention includes a main frame 12 supported by a pair of wheels 14. A tongue 16 is provided on the forward portion of the main frame 12 for connection to a tractor (not shown). A tailgate 18 is pivotally connected to the main frame 12 by stub shafts 20 so that the tailgate 18 may be closed as shown in Fig. 1 during bale formation and opened to eject a completed bale. A pair of hydraulic cylinders 21 is connected between the main frame 12 and the tailgate 18 to open and close the tailgate 18. A conventional pickup 22 is mounted on the main frame 12 by a pair of brackets 24 and is supported by a pair of wheels (not shown). The pickup 22 includes a plurality of fingers or tines 26 movable in a predetermined path to lift crop material from the ground and deliver it rearwardly toward a floor roll 28 which is rotatably mounted on the main frame 12.

A sledge assembly 29 includes a plurality of rollers 30, 32, 34 extending transversely of the main frame 12 in an arcuate arrangement and

journalled at the ends thereof in a pair of arcuately shaped arms 36. The arms 36 are pivotally mounted inside the main frame 12 on stub shafts 38 for permitting movement of the sledge assembly 29 between a bale starting position shown in Fig. 1 and a full bale position shown in Fig. 2. The rollers 30, 32, 34 are driven in a clockwise direction as indicated in Fig. 1 by conventional means (for example, chains and sprockets or gears) connected with a drive shaft 17 which is adapted for connection to the PTO of a tractor (not shown). A stripper roll 39 is located adjacent roller 30 and is driven in a clockwise direction, as viewed in Fig. 1, to strip crop material from the roller 30. An idler roller 40 is carried by the arms 36 for movement in an arcuate path when the sledge assembly 29 moves between its bale starting and full bale positions. The idler roller 40 is freely rotatable.

An apron 41 includes a plurality of belts 42 supported on guide rolls 44, 46, 48, 50, 52 which are rotatably mounted in the tailgate 18 and on a drive roll 54 which is rotatably mounted in the main frame 12. Although the belts 42 pass between the roller 34 and the idler roller 40, they are in engagement with only the idler roller 40 but the roller 34 is located in close proximity to the belts 42 to strip crop material from the belts 42.

When the round baler 10 is in the condition shown in Fig. 1 with the tailgate 18 closed, an inner course 42a of the apron belts 42 extending between the guide roll 52 and the idler roller 40 cooperates with the rollers 30, 32, 34 of the sledge assembly 29 to define a bale starting chamber 64. The apron inner course 42a forms a rear wall of the chamber 64 while the rollers 30, 32, 34 form a front wall of the chamber 64. The floor roll 28 is disposed in the bottom of the chamber 64 between the front and rear walls thereof. The roller 30 is spaced from the floor roll 28 to form a throat or inlet 66 for the chamber 64.

Further conventional means (not shown) are connected with the drive shaft 17 to provide rotation of the drive roll 54 for causing movement of the belts 42 along the path indicated in Fig. 1 and in the direction such that the inner course 42a is moving upwardly when starting a bale. An additional guide roll 55 in the main frame 12 ensures proper driving engagement between the belts 42 and the drive roll 54. A pair of take up arms 56 is pivotally mounted on the main frame 12 by a cross shaft 58 for movement between inner and outer positions shown in Figs. 1 and 2, respectively. These take up arms 56 carry additional guide rolls 60 and 62 for the belts 42. Resilient means such as a pair of springs 63 are provided to normally urge the arms 56 toward their inner positions. These springs 63 are connected at their upper ends to levers 59 which are mounted on the cross shaft 58 and at their lower ends to the tailgate 18.

As the round baler 10 is towed across a field by a tractor (not shown), the pickup tines 26 lift crop material from the ground and feed it into the bale starting chamber 64 via the throat 66. The crop material is carried rearwardly by the floor roll 28 into engagement with the apron inner course 42a which carries it upwardly and forwardly into engagement with the rollers 34, 32, 30. The crop material is coiled in a counterclockwise direction as viewed in Fig. 1 to start a bale core. Continued feeding of crop material into the chamber 64 by the pickup tines 26 causes the apron inner course 42a of the belts 42 to expand in length around a portion of the bale core as the diameter thereof increases. The take up arms 56 rotate from their inner position shown in Fig. 1 toward their outer position shown in Fig. 2 to permit such expansion of the apron inner course 42a. When a full sized bale has been formed as shown in Fig. 2 and then wrapped with a suitable material such as twine or net, the tailgate 18 is opened by extending the hydraulic cylinders 21 and the bale is ejected. Subsequent closing of the tailgate 18 returns the apron inner course 42a to the location shown in Fig. 1 since the arms 56 are returned to their inner positions shown in Fig. 1 by the springs 63. The round baler 10 is now ready to form another bale.

It will be understood that during formation of the bale, the sledge assembly 29 moves from its bale starting position of Fig. 1 to its full bale position of Fig. 2. This movement of the sledge assembly 29 causes the idler roller 40 to move in an arcuate path while maintaining the apron belts 42 in close proximity to the roller 34, thereby allowing the roller 34 to strip crop material from the apron belts 42. The idler roller 40 thus prevents the loss of crop material between the roller 34 and the belts 42 during formation of the bale. The sledge assembly 29 is pushed outwardly toward its full bale position during bale formation and is pulled inwardly toward its bale starting position during bale ejection without utilizing any additional mechanisms.

In an alternative embodiment (not shown) of the round baler 10, the apron 41 consists of a pair of chains connected together at spaced intervals by transverse slats, and the idler roller 40 is replaced by a pair of idler sprockets engaged with the chains. Also in this alternative embodiment, the guide rolls 44, 46, 48, 50, 52, 55, 60 and 62 are replaced with guide sprockets for engaging the apron chains, and the drive roll 54 is replaced with drive sprockets.

In accordance with the present invention, a pair of hydraulic cylinders 68 is pivotally connected at their ends between lever arms 70 which are mounted on the cross shaft 58 and frame members 72

on the tailgate 18. The hydraulic cylinders 68 are preferably of the double acting type. One of the springs 63 and one of the hydraulic cylinders 68 are disposed on each side of the baler 10.

As seen in Fig. 1, the longitudinal axes of the hydraulic cylinders 68 are inclined at an acute angle of approximately 30° relative to the longitudinal axes of the springs 63 at the start of bale formation. This angle of inclination between the cylinders 68 and the springs 63 decreases to approximately 10° as seen in Fig. 2 when a full bale has been completed. It further also will be seen in Figures 1 and 2 that the lever arms 59 and 70 equally are inclined at an acute angle of approximately 30° relative to each other.

During bale formation, the hydraulic cylinders 68 and the springs 63 are extended in order to resist movement of the arms 56 from the inner positions shown in Fig. 1 to the outer positions shown in Fig. 2. This maintains tension in the apron 41 and thereby controls the density of bales formed in the baler 10.

It will be appreciated from a careful analysis of the drawings that, in the empty condition of the baler 10 (Fig. 1), the lever arms 59 and the longitudinal axes of the springs 63 extend generally perpendicularly to each other and, when a full sized bale is formed in the bale chamber (Fig. 2), these arms 59 and longitudinal axes of the springs 63 define an acute angle therebetween whereby, during bale formation, the effective torque arms of the spring forces gradually are shortened while the spring forces themselves increase. These counteracting effects tend to compensate each other more or less so that the effective torques applied by the springs 63 on the take up arms 56 remain substantially constant during bale formation.

The hydraulic cylinders 68 are included in a hydraulic system further also comprising an adjustable relief valve (not shown) in the hydraulic circuitry between the plunger sides of the cylinders 68 and a pressure fluid reservoir (not shown). The cylinder sides of the hydraulic cylinders 68 are coupled both via a by-pass and incorporated check valve to the plunger sides thereof and via further hydraulic fluid supply lines to said reservoir. Said hydraulic circuitry may include a shut off valve for enabling interruption of the drainage of pressure fluid from the cylinder sides of the hydraulic cylinders 68. The purpose of this shut off valve will become clear furtheron in the description.

The arrangement of the hydraulic apron tension control system is such that extension of the hydraulic cylinders 68 and thus also outward movement of the take up arms 56, is opposed by a predetermined resistance which is adjustable by means of said relief valve. This resistance remains constant during the entire bale formation. Having said this, it further also may be derived from the drawings that the relative positioning of the lever arms 70 and the hydraulic cylinders 68 is such that the effective torque arms of the hydraulic resistance forces increase during bale formation whereby the effective torques applied by the hydraulic cylinders 68 on the take up arms 56 increase which is desirable as the tension in the belts 42 should increase together with the increasing diameter of a bale being formed in the bale chamber to thereby ensure that this bale has the desired density throughout.

In summary, the hydraulic apron tension control system described hereabove in effect is formed by resisting means which, during bale formation, resist movement of the apron take up means toward the full sized bale position.

It will be understood that the springs 63 and the hydraulic cylinders 68 cooperate to comprise apron tensioning means according to the present invention. The hydraulic cylinders 68 provide a primary source of tension on the apron 41 while the springs 63 provide a secondary source of tension on the apron 41 and assist the cylinders 68 during formation of the bale core and during the final stages of bale formation. As already explained, the apron tension generated by the hydraulic cylinders 68 increases during bale formation while the apron tension generated by the springs 63 remains substantially constant during bale formation. The apron tension generated by the springs 63 is relatively small but yet sufficient so that a core of sufficient density may be formed. At the start of the bale formation, the hydraulic tensioning means provide virtually no apron tension whereby the loads on the apron are relatively small, which is of course desirable from the viewpoint of wear and tear. On the other hand, when a bale grows in the bale chamber toward a full size bale, increased apron tension is needed to produce adequate bale density. This increased apron tension is generated mainly by the hydraulic apron tensioning system as already described. Thus, increased apron tension is generated only when required.

In summary, this cooperation between the springs 63 and the hydraulic cylinders 68 ensures that bales formed in the baler 10 have dense cores and hard outer shells. Such bales are preferred because the dense cores prevent bales from sagging or squatting after formation and the hard outer shells help to shed water and thus prevent it from penetrating into the bales.

When the tailgate 18 is closed after ejecting a completed bale, the hydraulic cylinders 68 are contracted and this is accomplished by means of the springs 63 which urge pressure fluid from below the plungers of the cylinders 68 past the shut off valve, on the one hand, in part via the by-pass and

incorporated check valve into the plunger sides of these cylinders 68 and, on the other hand, in part back to the reservoir. This results in the take up arms 56 returning to their bale starting position of Fig. 1. The resetting of the hydraulic tensioning means indeed is accomplished by the springs 63 in as much as the hydraulic tensioning means do not include a powered pressure source.

Should servicing of the apron belts 42 become necessary, then the tailgate 18 is raised whereby, by virtue of, on the one hand, the cross shaft 58 of the apron tensioning mechanism being provided on the main frame 12; the anchorage points of the apron tensioning cylinders 68 being provided on the tailgate 18 and the relative positioning of the lever arms 70 and said tensioning cylinders 68 and, on the other hand, the apron belts 42 extending around rollers 54 and 40 positioned on the main frame 12 at locations forwardly of the tailgate pivots 20, the tensioning cylinders 68 are caused to extend and thus, pressure fluid is caused to enter the cylinder sides of these cylinders 68. Next, the operator closes the aforementioned shut off valve whereby, upon subsequent lowering of the tailgate 18, contraction of the apron tensioning control cylinders 68 is prevented. This, in turn, results in the take up arms 56 becoming blocked and inoperative and thus, in the apron belts becoming loose, i.e. the apron tension being fully released, which is highly desirable and normally even required for servicing these apron belts.

Claims

1. A round baler (10) comprising :
- bale forming apron means (41) having an inner course (42a) defining at least in part a bale forming chamber which, in use, is expandable from a bale starting chamber (64) to a full sized bale chamber; said apron inner course (42a) being extensible to at least in part accomodate for said bale chamber expansion and,
- means (56, 63, 68) for tensioning the apron means (42) during bale formation; said apron tensioning means (56, 63, 68) including :
. take up means (56, 60, 62) cooperable with the apron means (41) and movable from a bale starting position to a full sized bale position to permit extension of the apron inner course (42a) during said bale formation, and
. resilient means (63) cooperable with the take up means (56, 60, 62) for normally urging said take up means (56, 60, 62) toward the bale starting position and permitting these take up means (56, 60, 62) to move toward the full sized bale position during said bale formation, and
characterized in that :
the apron tensioning means (56, 63, 68) also comprise resisting means (68) cooperable with the take up means (56, 60, 62) for, together with the resilient means (63), providing resistance to the take up means (56, 60, 62) when moving from said bale starting position to said full sized bale position to thereby induce tension in the apron means (41) during said bale formation.

2. A round baler (10) according to claim 1 characterized in that the take up means are formed by a single take up apparatus (56, 60, 62, 58, 59, 70).

3. A round baler (10) according to claim 2 characterized in that the take up apparatus (56, 60, 62, 58, 59, 70) comprises :
- a pair of arms (56) pivotally mounted on the baler (10) by a common shaft (58) and carrying guide means (60, 62) for the apron means (41), and
- first and second lever means (59, 70) connected at one of their ends to said common shaft (58); said resilient means (63) and said resisting means (68) being coupled to the other ends of respectively said first and second lever means (59, 70).

4. A round baler (10) according to any of the preceding claims characterized in that :
- the resilient means are formed by spring means (63), and
- the resisting means are of the hydraulic type including hydraulic cylinder means (68) incorporated in a hydraulic circuitry also comprising adjustable relief valve means.

5. A round baler (10) according to claim 4 when appended to claim 3 and comprising a main frame (12) and a tailgate (18) pivotally connected to said main frame (12); said baler (10) being characterized in that :
- the take up apparatus (56, 60, 62, 58, 59, 70) is pivotally mounted on the main frame (12), and
- the hydraulic cylinder means (68) are connected between said second lever means (70) of the take up apparatus (56, 60, 62, 58, 59, 70) and said tailgate (18) for resisting movement of said take up apparatus (56, 60, 62, 58, 59, 70) from said bale starting position to said full sized bale position.

6. A round baler (10) according to claim 5 characterized in that the spring means (63) are connected between said first lever means (59) of the take up apparatus (56, 60, 62, 58, 59, 70) and said tailgate (18) for normally urging said take up apparatus (56, 60, 62, 58, 59, 70) toward said bale starting position.

7. A round baler according to claim 5 or 6 characterized in that :
- the second lever means comprise a pair of second levers (70) connected at one of their ends to said common shaft (58) at opposite sides of the baler (10), and
- the hydraulic cylinder means comprise a pair of

hydraulic cylinders (68), each having one end thereof connected to one of said second levers (70) and the other end thereof connected to said tailgate (18) at the corresponding side thereof.

8. A round baler (10) according to claim 7 when appended to claim 6, characterized in that :
- the first lever means comprise a pair of first levers (59) connected at one of their ends to said common shaft (58) at opposite sides of the baler (10), and
- the spring means comprise a pair of springs (63), each having one thereof connected to one of said first levers (59) and the other end thereof connected to said tailgate (18) at the corresponding side thereof.

9. A round baler (10) according to any of the preceding claims characterized in that the tension generated in the apron means (41) by the resisting means (68) increases during bale formation while the tension generated in said apron means (41) by the resilient means (63) remains substantially constant during bale formation.

10. A round baler (10) according to any of the preceding claims characterized in that, during operation, the resisting means (68) provide a primary source of tension in the apron means (41) while the resilient means (63) provide a secondary source of tension in said apron means (41).

11. A round baler (10) according to any of the preceding claims characterized in that it further also comprises a sledge assembly (29) including a plurality of rollers (30, 32, 34); said sledge assembly (29) being mounted for movement between a bale starting position and a full bale position and cooperable with the inner course (42a) of the apron means (41) to define said bale forming chamber therebetween.

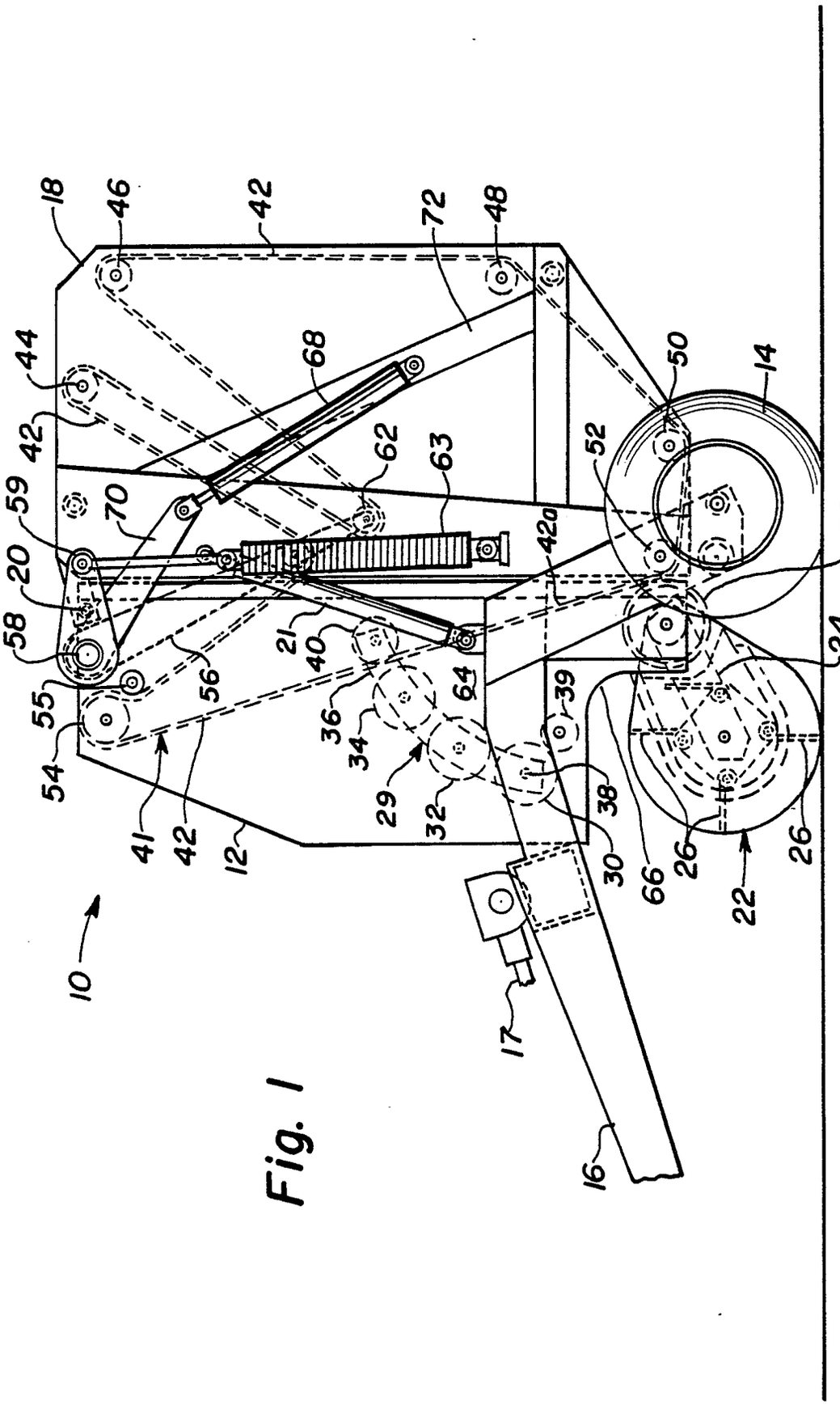
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Fig. 1

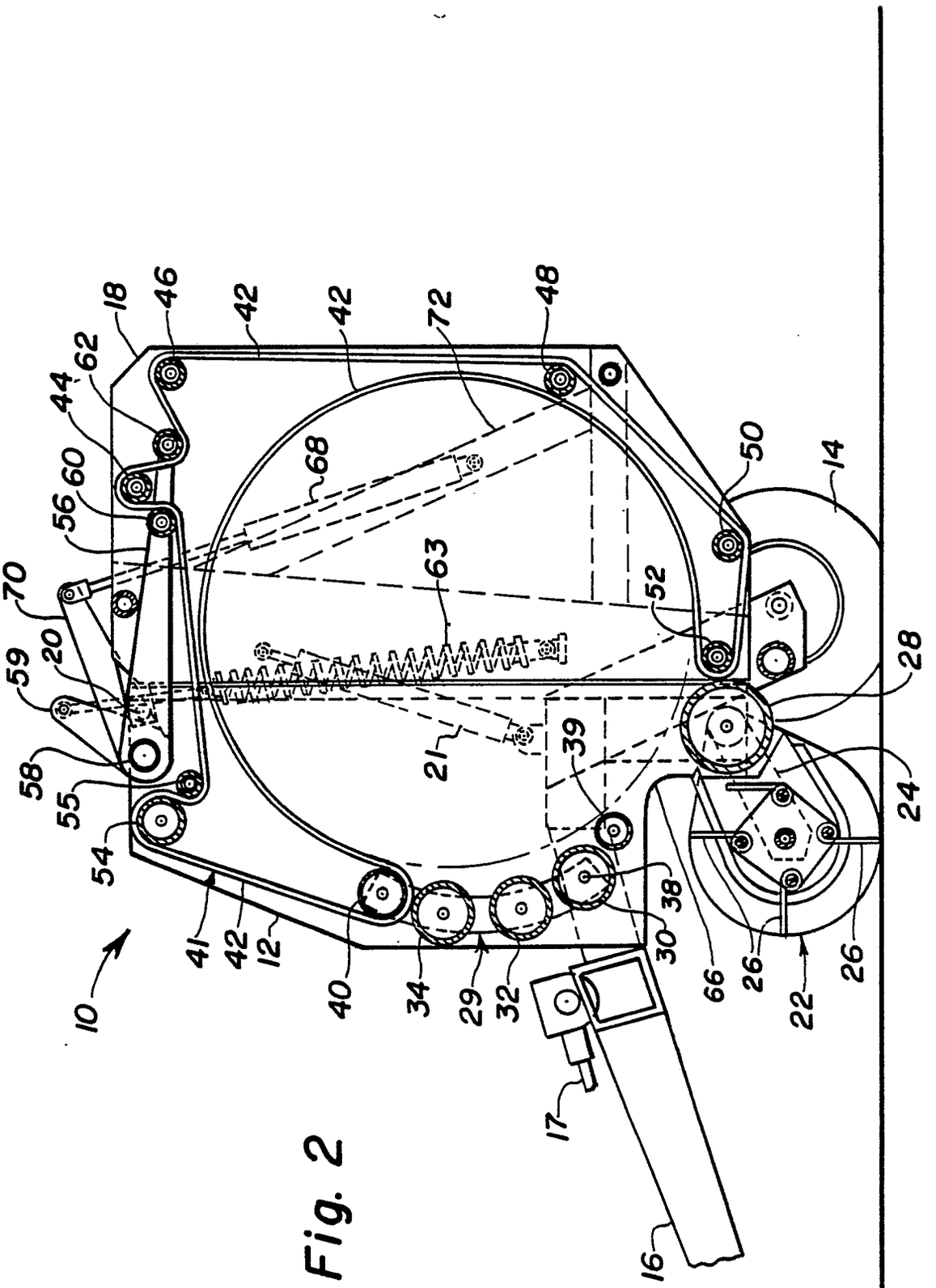
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Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 20 2541

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-76502 (DEERE) * pages 5 - 11; figures 1-6 *	1, 2, 4, 6, 7, 8, 9, 10	A01F15/07
X	EP-A-235356 (DEERE) * page 2, line 20 - page 5, line 8; figures 1-3 *	1, 3, 4, 5, 7, 8, 9, 10	
A	FR-A-2383599 (I.H.C.) * page 2, line 23 - page 5; figures 1, 2, 3 *	1, 2, 3, 6	
A	FR-A-2541560 (RIVIERRE CASALIS)		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			A01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 JANUARY 1990	VERMANDER R.H.

CATEGORY OF CITED DOCUMENTS

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